IS 11642-2 (1986): Aluminium Hexagonal Honeycomb Core, Part 2: Methods of Tests [TED 14: Aircraft and Space Vehicles]

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UDC 629·73·023·4-478 : 669·71 : 620-1

(Reaffirmed 2002)

Indian Standard

SPECIFICATION FOR ALUMINIUM HEXAGONAL HONEYCOMB CORE

PART 2 METHODS OF TESTS

Aircraft and Space Vehicles Sectional Committee, EDC 74; Panel for Honeycomb Sandwich Panels for Aircraft, EDC 74/P3 [Ref : Doc : EDC 74 (4264)]

1. Scope — Covers the methods of tests for honeycomb core used for sandwich construction of aircraft floors. Part 1 of this specification covers the general requirements.

2. Classification of Tests

a) Acceptance tests, and
b) Type tests.

2.1 The following tests shall constitute the acceptance tests:

a) Density,
b) Bare compressive strength and modulus,
c) Stabilized compressive strength and modulus, and
d) Core shear strength and modulus (in both *L* and *W* directions).

2.2 The following tests shall constitute the type tests:

a) Density,
b) Bare compressive strength and modulus,
c) Core shear strength and modulus (in both *L* and *W* directions), and
d) Node bond strength.

3. Test Conditions

3.1 The room temperature and relative humidity for conducting the tests shall be $20 \pm 1°C$ and 50 ± 5 percent, respectively. The testing machine shall be capable of an accuracy of 1 percent of true applied load and shall not deviate by more than 25 percent of the specified speed rate. The test specimens shall be conditioned before commencement of tests.

4. Acceptance Tests

4.1 *Density* — Shall be determined on a cubic metre in accordance with Appendix A and expressed in N/m^3.

4.2 *Bare Compressive Strength and Modulus* — Shall be determined in accordance with Appendix B.

4.3 *Stabilized Compressive Strength and Modulus* — Shall be determined in accordance with Appendix **C**

4.4 *Core Shear Strength and Modulus* — Shall be determined in accordance with Appendix **D**.

5. Type Tests

5.1 *Density* — Shall comply with **4.1**.

5.2 *Bare Compressive Strength and Modulus* — Shall comply with **4.2**.

5.3 *Core Shear Strength and Modulus* — Shall comply with **4.4**.

5.4 *Node Bond Strength* — Shall be determined in accordance with Appendix E.

5.5 *Thickness of Core* — Shall be determined in accordance with Appendix F.

6. Sampling

6.1 For the purpose of lot sampling, a lot may be defined as a group of 20 or less cores of the same type, fabricated from the same print, cured under the same conditions and manufactured under the same press.

6.2 At least 5 specimens shall be used for tests in **4** and **5** from each lot.

Adopted 31 March 1986 | | Gr 4

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APPENDIX A

(*Clause* 4.1)

TEST METHOD FOR DENSITY OF HEXAGONAL HONEYCOMB CORES

A-1. Scope — This method covers the determination of density of hexagonal honeycomb cores.

A-2. Test Specimen — The test specimens shall be 76 mm in width and 76 mm in length with the thickness of the sandwich core required. At least five specimens shall be tested.

A-3. Test Conditions — Condition the core material to constant weight at a temperature of 23±1·1°C and 50±2 percent relative humidity.

A-4. Procedure — Determine the weight and also the dimensions of the specimen to an accuracy of ±0·5 percent.

A-5. Calculations

$$\text{Density of core } d = \frac{w}{v} \times 10^9$$

where

d = density in Newtons per cubic metre,

w = final weight after conditioning (Newtons), and

v = final volume after conditioning cubic millimetre.

A-6. Test report shall contain the following:

a) Brief description of the material and size of the test specimen,

b) Core designation and number of specimens tested,

c) Conditioning procedure, and

d) Density.

APPENDIX B

(*Clause* 4.2)

BARE COMPRESSIVE STRENGTH AND MODULUS TEST

B-1. Scope — This test measures the compressive strength only and is often proposed as an acceptance test for honeycomb cores. This test is for bare cores only; that is, face sheets are not bonded and edges not reinforced as in the case of stabilized block compression tests.

B-2. Test Specimen — Specimen shall be for any core thickness (12 mm *Min*) and shall be at least 250 × 250 mm in cross-section. The test slice shall be cut so that the thickness does not vary by more than ±0·5 percent. No end coatings shall be used. At least five specimens shall be tested for a type.

B-3. Test Apparatus — Any form of standard compression testing machine capable of operation at a constant rate of motion of the movable head. A compression ram at least 65 mm in diameter and large enough for cores having larger cells to include at least one complete cell.

B-4. Test Procedure — Support the test slice over its entire area on lower plate of the testing machine and press the compression ram into the slice. Apply the load at a constant rate of movement and at such a rate that the maximum load will occur between 3 and 6 minutes. A suggested rate of ram movement is 0·038 mm per minute.

B-5. Calculation — Calculate the compressive strength by dividing the maximum load by the area of the ram.

B-6. Test Report — The test report shall contain the following:

a) Core designation;

b) Dimensions of test specimens and size of ram;

c) Testing conditions, temperature, relative humidity and speed of testing;

d) Compressive strength, individual values and averages; and

e) Description of failed specimen including location and type of failure.

APPENDIX C

(*Clause* 4.3)

STABILIZED CORE COMPRESSIVE STRENGTH AND MODULUS

C-1. Scope — The method covers determination of the compressive strength and modulus of sandwich honeycomb core. This property is usually determined for design purposes in a direction along the axis of the core.

C-2. Test Specimen — Test specimens shall be of sandwich construction (that is, stabilized core that has face sheets bonded to the core) and shall be a square of circular cross-section having areas not exceeding 10 000 mm^2 but not less than the following minimum areas. For cells larger than 12 mm the area of specimen shall be a minimum of 2 500 mm^2 or large enough to include at least one complete cell. The height of the specimen shall not be greater than four times the width or diameter. Not less than five specimens of a type shall be tested.

C-2.1 Prepare the test specimens so that the loaded ends will be parallel to each other and perpendicular to the sides of the specimen. In order to avoid local crushing of honeycomb cores at the ends, it is desirable to reinforce the ends with a suitable material. The ends may be cast or dipped in a thin layer of resin (epoxy, polyester or furane resin has been found satisfactory) and cured at room temperature or slightly elevated temperature. It has been found that a depth of resin as little as 2 mm will provide adequate support for many types of cores so as to prevent localized failures.

C-3. Test Apparatus — Any form of standard compression testing machine capable of operation at a constant rate of motion of the movable head, with self-aligning grips shall be used. Suitable means for measuring strains in honeycomb cores consist of filar microscopes focussed on points of fine needles inserted in the core.

C-4. Test Procedure — Apply the load to the specimen through a spherical loading block, preferably of the suspended, self-aligning type, in such a manner that the block distributes the load as uniformly as possible over the entire loading surface of the specimen. Apply the load at a constant rate of movement of the movable head of the testing machine (Note 1) and at such a rate that maximum load (Note 2) will occur between 3 and 6 minutes.

Note 1 — A suggested rate of head movement is 0·003 mm/min/mm of core height. For accurate determination of the properties of the core, it will be desirable to test under continuously applied load.

Note 2 — For cores without definite maximum load, the maximum load shall be the load at 2 percent strain or if head-movement is measured the maximum load shall be the load at 10 percent total compression.

C-5. Calculation — Data for stress-strain curves may be taken to determine the modulus of elasticity, proportional limit stress at 0·2 percent strain offset and the maximum load at 2 percent strain (*see* Note 2). Usually 12 readings are adequate to determine the curve to the proportional limit. Measure deformations to the nearest 0·002 mm using filar microscopes focussed on points of fine needles inserted in the core. The filar microscope shall measure strain over the central portion of the length of the specimen over a gauge length not exceeding two-thirds of the length of the specimen.

C-6. Test Report — The report shall include the following:

a) Complete description of the test specimens including materials, resins, adhesives, type of end support, etc;

b) Dimensions of test specimens;

c) Testing conditions, including temperature, relative humidity and speed of testing;

d) Stress-strain or load-deformation diagrams;

e) Compressive strength and modulus individuals values and averages; and

f) Description of failed specimen including location and type of failure.

APPENDIX D

(*Clause* 4.4)

CORE SHEAR STRENGTH AND MODULUS TEST

D-1. Scope — This method covers the determination of shear strength parallel to the plane of the honeycomb core and the shearing modulus associated with strains in a plane normal to the facings bonded to the honeycomb core. The test shall be carried out in both *L* and *W* directions.

D-2. Test Specimens — The test specimens shall have honeycomb core thickness of 20 mm ± 0·05 mm, width 50 mm ± 0·25 mm and length 250 mm ± 1·0 mm. Steel plates of sufficient thickness depending on the strength of the core shall be bonded to the core, but the plate dimension shall be such that the line of action of direct tensile force shall pass through the diagonally opposite corners of the sandwich as shown in Fig. 1. (It has been found that loading plates having a stiffness of not less than $2{\cdot}59 \times 10^6$ N. mm²/mm width per millimetre of core thickness have performed satisfactorily.)

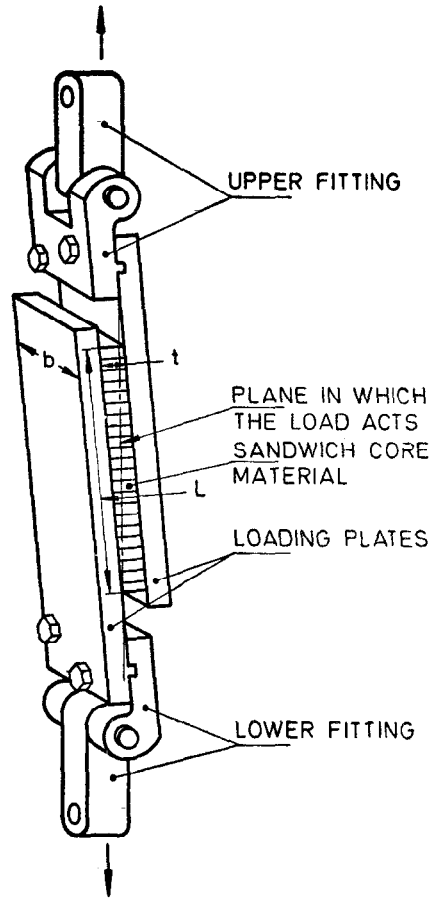


FIG. 1 ARRANGEMENT OF TEST SPECIMEN FOR SHEAR TEST IN TENSION

D-3. Test Procedure — Apply the load to the ends of the rigid plates in tension through a spherical bearing block or a universal joint so as to distribute the load uniformly across the width of the specimen. Apply the load at a constant rate of movement of the movable head of the testing machine such that the maximum load will occur within 3 to 6 minutes. (Recommended rate is 0·005 mm/min per mm of specimen length. It is permitted to stop loading head intermittently to obtain deformation data.)

Obtain 12 load-deformation readings, preferably at equal strain increments to define the shape of the stress-strain diagram. Read the deformation to the nearest 0·002 mm by means of a dial gauge shown in Fig. 2.

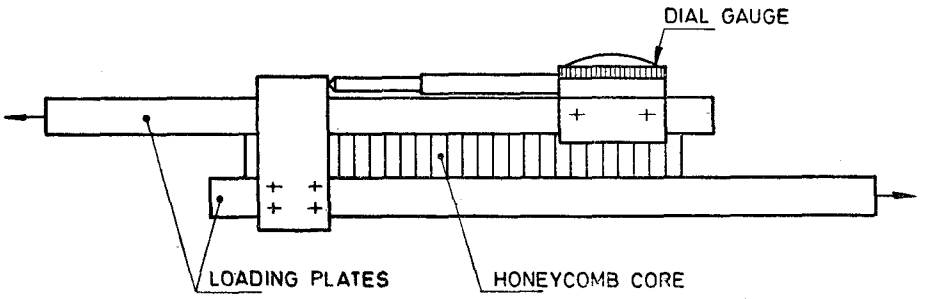


FIG. 2 ARRANGEMENT OF DIAL GAUGE TO MEASURE DISPLACEMENT OF ONE PLATE WITH RESPECT TO OTHER

D-4. Calculations — Calculate the shear stress as follows:

$$f_s = \frac{p}{L \times b}$$

where

f_s = shear stress, pascals (P_a);
p = load on specimen, N;
L = length of specimen, mm; and
b = width of specimen, mm.

Obtain the shear strength of the core by this formula when p equals the maximum load.

$$\text{Shear strain } \gamma = \frac{r}{C}$$

where

r = dial reading or movement of one loading plate of the specimen with respect to the other; and

C = distance between loading plates, that is, the thickness of the core.

and shear modulus of core $G_e = \frac{f_s}{\gamma} = \frac{f_s \times C}{r}$

D-5. Test Report — The test report shall include the following:

a) Core designation,
b) Dimensions of test specimen,
c) Stress-strain or load-deformation diagrams,
d) Shear strength and shear modulus of honeycomb core,
e) Description of specimen failure, and
f) Orientation of core (L or W).

APPENDIX E

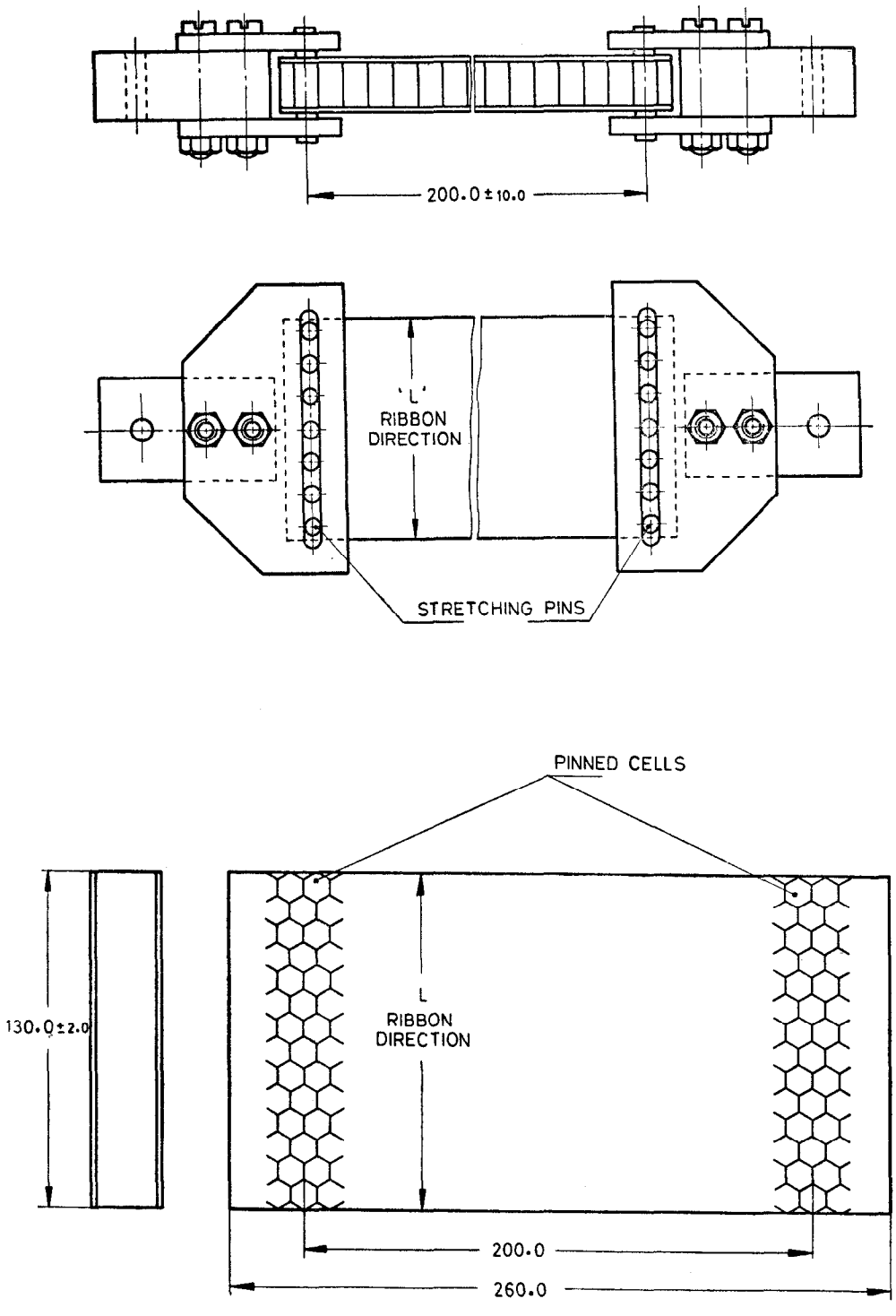
(*Clause* 5.4)

NODE-BOND STRENGTH OF HONEYCOMB CORE MATERIAL

E-1. Scope — This method covers determination of node to node bond strength of honeycomb core materials. The test is useful in determining whether cores can be handled during expansion, cutting and machining without delaminating.

E-2. Test Specimen — The test specimen shall be 130 ± 2 mm wide by 260 ± 10 mm long with a test section outside the grips of 200 ± 10 mm. The specimen width shall be parallel to the node-node bond areas. The thickness of the core shall be 12·0 ± 0·1 or 16·0 ± 0·1 mm. A minimum number of five specimens shall be selected from that portion of the material which appears to have a maximum number of distorted cells or misalignment of bond areas.

E-3. Test Apparatus — The fixture shall be as shown in Fig. 3. The tension testing device capable of slow uniform head motion that may indicate the load at failure to within one percent accuracy with grips of multiple pin type or clamping type shall be used. For multiple pin types the fixture shall be slotted to permit horizontal movement of the pins.



All dimensions in millimetres.

FIG. 3 NODE BOND TEST FIXTURE

E-4. Preparation of Specimens — In the event that a clamping type of grip is to be used, the specimen ends can be reinforced against crushing by filling with plaster or reinforcing with a dip coating of resin.

E-5. Test Procedures — Apply tensile load normal to the ribbon so as to produce a constant rate of grip separation and record the ultimate load developed. Failure in the grip shall be considered a satisfactory test provided the test values obtained are equivalent or exceed the applicable specification value.

E-6. Calculation — Calculate the node-to-node bond strength as follows:

$$F_u = P/LT$$

where

F_u = node-to-node bond strength, P_a;

P = ultimate tensile load, N;

L = width of specimen, mm; and

T = thickness of the specimen, mm.

E-7. Test Report — Test report shall contain the following information:

a) Core designation,

b) Dimensions of the test specimen, and

c) Node-to-node bond strength calculated.

APPENDIX F

(*Clause* 5.5)

MEASUREMENT OF THICKNESS OF SANDWICH HONEYCOMB CORES

F-1. Scope — Two methods are covered to measure the thickness of flat sandwich honeycomb cores;

a) Method A — Roller type thickness tester

b) Method B — Disc type thickness tester

F-2. Test Specimen — The test specimen shall be flat but otherwise may be any length, width, and thickness consistent with the limits of the measuring apparatus.

F-3. Test Apparatus

a) *Roller Type Thickness Tester* — The tester shall consist of a flat table with a rigid yoke frame work attached. Two rollers shall be mounted on this yoke, one fixed in position and one movable in the vertical direction. The vertical movement of the upper roller shall be translated to a dial gauge calibrated in 0·01 mm increments, that registers the amount of variation above or below a pre-set nominal dimension. The lower roller shall be fixed in position so that it projects 6 mm above the surface of the table. The upper roller shall exert a force of 18 N (1·81 kg) in the core material.

b) *Disc Type Thickness Tester* — The tester shall consist of a flat table with a rigid yoke frame-work attached. A 25 mm dia presser disc movable in a vertical direction shall be mounted on the yoke. The vertical movement of the disc shall be translated to a dial gauge calibrated in 0·002 mm that registers the amount of variation above or below a pre-set nominal dimension.

The disc shall exert a force of 24 N (2·4 kg) on the core material.

F-4. Test Procedure — Place a spacer bar of a thickness equal to the desired nominal core thickness between the rollers or beneath the disc, and zero the dial gauge. Remove the spacer bar and insert the core material to be measured. Move the core through the rollers back and forth and observe the dial gauge readings. In the case of disc type, move the core in a saw tooth pattern along the length of the specimen and observe the dial gauge readings. If the honeycomb sample is excessively wrapped and the weight of the presser disc is not sufficient to straighten it, use an additional adjustable presser ring concentric with the 25 mm dia presser foot to force the sample to lie flat on the metal base plate. The outside diameter of this ring shall be 120 mm.

Care shall be taken as not to exert hand pressure on the core, as this will affect the dial gauge readings.

EXPLANATORY NOTE

Reference has been made to the following while preparing this part of the specification for aluminium core for use in panels of aircraft floor:

MIL-STD-401B	General test methods for sandwich construction and core materials
MIL- C 7438 F	Core material, aluminium, for sandwich construction
ASTM C 273-1961	Method of shear test in flatwise plane of sandwich construction of sandwich core
ASTM C 363-1957	Test method for delamination strength of honeycomb type core materials
ASTM C 365-1957	Test method for flatwise compressive strength of sandwich cores
ASTM C 366-1967	Test method for measurement of thickness of sandwich cores

Separate specifications for core materials, adhesives, etc, are under preparation.

Part 1 of this specification covers the general requirements for aluminium cores that are used in sandwich constructions for the floor panel. Separate specification has also been drawn up for the floor panels using aluminium face sheets and cores in their construction.

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